THE DESIGN, CONSTRUCTION, AND EVALUATION
OF A FIBER GLASS SPORTS CAR BODY

by
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CHAPTER I

INTRODUCTION

The automobile manufacturers are constantly competing for design and technological advantages over their competitors in order to persuade and sway the buying public. Factories often make current alterations to the body design for the sake of change to appeal to the fickle aesthetic tastes of the automobile purchaser. The millions of dollars involved in effecting production body changes dictate the necessity for automobile design engineers to economically devise small scale as well as full size experimental designs using the most practical methods of modern technology. The automobile manufacturers build many one-of-a-kind prototype vehicles for design inspirations to gain as much advantage as possible over their rivals before tooling for new model changes.

The construction of automobile bodies built of reinforced plastic dates back to 1940 when Henry Ford publicized his by striking a sledge hammer blow on the rear deck lid of his Ford sedan.1 Fiber glass reinforced laminates are stronger than metals, yet are lighter, weighing one fifth as much as steel and one third less than aluminum.

Most experimental automobile bodies are physically shaped to be constructed of fiber glass by their usual assemblage of compound curves, demand upon rigidity, consideration of weight, and the potentially vast expense involved for one-of-a-kind productions.

The experimentor became interested in designing a light weight streamlined sports car body capable of contributing toward higher performance when mounted upon a Volkswagen sedan chassis. The fiber glass sports car body was designed, constructed, and mounted upon a forty horsepower Volkswagen chassis in the body and fender laboratory of East Bakersfield High School, Bakersfield, California during the 1967-1968 school year.

Statement of the Problem

The purpose of this study was three fold: (1) To design a sports car body and to develop figures and drawings to evolve the body shell which could be constructed and mounted upon a Volkswagen automobile chassis in the school shops; (2) to choose suitable materials for constructing the unit and to fabricate and finish the project into a useful piece of equipment; and (3) to test and evaluate the unit and demonstrate its functional use to others.
The design stage involved the integration of research, ideas, knowledge, and skills. The construction stage involved the selection of materials and the construction of the object. The testing and evaluation involved driving the vehicle and determining its effectiveness and usefulness as a piece of equipment for which it was designed.

Need for the Study

Teachers in the field of industrial arts are constantly confronted with the rapid advancement of modern technology. The processes involved in using fiber glass in the designing, construction, and evaluation of experimental bodies are understood by industry and are adaptable for learning experiences for students in the industrial education classes. Through the construction of this fiber glass sports car body, students were able to understand more about functional automobile design and the techniques for manipulating fiber glass reinforced plastics.

Delimitations of the Study

This study was limited to the design, construction and evaluation of a functional prototype fiber glass sports car body to mount upon a Volkswagen automobile chassis. Also, this study was to determine the suitability of such a project for use in a senior high school automobile body and fender repair laboratory.
Source of Data

The research of available literature in books and periodicals was done in the library of Fresno State College, Fresno County Library, Kern County Free Library, East Bakersfield High School Library, and Kern County Joint Union High School District Professional Library.

Additional information was obtained from manufacturers' literature and personal interviews with those in the fiber glass, plastics, boat, and automobile industries.

Definitions of Terms Used

Body Putty: A highly filled polyester resin compound with approximately fifty parts of resin and fifty parts of filler. This putty is extensively used in the fiber glass and automobile body repair industry.

Cavity mold: A term for a female mold. In this study the laminating was accomplished on the inside of the mold.

Fiber glass: Fibers similar to wool or cotton fibers, but made from glass; sometimes called fibrous glass. Many different products are made from these fibers, such as cloth, yarn, mat, milled fibers, chopped strands, roving, woven roving, and surfacing mat.
**Gel coat:** A thin surface coat, either colored or clear, of properly cured plastic resin which does not contain glass materials.

**Lamination:** The laying on of layers of glass materials and resin, much like the build-up of plywood.

**Mat:** Strands of fiber glass in a random pattern. These strands are bonded together into a thick layer, using any of a variety of bonding agents. This mat may weigh from three-fourths to ten ounces per square foot. It is thicker than glass cloth and it will build up faster than glass cloths in the mold.

**Mold release:** A substance used to coat the mold to prevent the molded laminate from sticking to the mold.

**Plasticized clay:** Clay that never hardens and is always pliable.

**Polyester resins:** Polyester resin is the most popular resin group used with fiber glass materials. Polyester resin is thermosetting (cured or set by heat), all the materials within the resin react and there are no by-products resulting from the cure. In room temperature cures, the catalyst is usually methyl-ethyl-ketone peroxide. The cure time is controlled by room temperature and humidity during application and cure, as well as the amount of catalyst added to the resin.
**Plug mold**: A plug or plug mold is a male or convex mold used in thermoforming.

**Polyvinyl alcohol**: Polyvinyl alcohol (PVA) is a film-forming mold release that is usually sprayed or brushed onto the mold to prevent the fiber glass project from sticking.

**Primer-surfacer**: A combination type of paint that is usually sprayed onto the surface of the project. The primer part of the paint has the ability to adhere to and protect the material covered, and the surfacer part of the mixture is designed to fill small scratches and depressions.

**Resin**: A liquid plastic substance used to surround glass fibers. It is cured by cross linking its molecules by heating. It is usually thick like honey.

**Spot putty**: A putty type of material especially formulated for filling minute scratches, indentations, and other small imperfections on primered surfaces.

**Sealer**: A special formulated paint sprayed over a primer-surfacer to seal the sandpaper scratches before applying the finish paint.

**Woven roving**: Continuous strands of glass fibers which are grouped together and woven similar to basket weave. Woven roving is identified by its weight per square yard.
CHAPTER II

REPORT OF THE STUDY

In reviewing learning exercises for automobile body and fender repair, it became evident that a need existed for experimentation with new projects and materials to bridge the gap between aesthetic and technological achievement. Research and experimentation into the molding of fiber glass shapes created the desire to design, construct, and evaluate a fiber glass sports car body mounted upon a Volkswagen sedan chassis. This desire was fulfilled in the spring of 1968 upon the completion of the project (see Figures 1, 2, and 3).

FIGURE I
FIBER GLASS BODY SPORTS CAR
FIGURE 2
FIBER GLASS BODY SPORTS CAR

FIGURE 3
FIBER GLASS BODY SPORTS CAR
Creative and Design Stage

A fiber glass sports car body was designed and constructed in the body and fender repair laboratory at East Bakersfield High School, Bakersfield, California.

Research of existing sports and racing cars led the experimenter to believe that by combining original ideas with the desirable features discovered, a suitable fiber glass sports car body could be created and constructed. The design incorporated the following categories:

1. Predesign,
2. Specifications consideration,
3. Model construction, and
4. Design.

Predesign. The preliminary designing of the sports car body in this study was set into motion by reading available automobile magazines, customizing and design literature, and other pertinent information of that which had already been accomplished. Pencil sketches were drawn and desired contours were combined to arrive at a reasonable beginning for the chosen design.

Specifications consideration. Fixed specifications for designing this prototype sports car body were both desirable and mandatory to meet both practical and legal operation of the full size car on the public highways. The
body was designed with the safety and comfort of the occupants the prime factors of consideration. To accomplish this aim the following concepts had to be recognized:

1. Headlight centers twenty four inches above the ground.
2. Windshield and side windows made of approved safety glazing material.
3. Suspension system had to have full travel.
4. Side doors, trunk space, and engine compartment had to be fully functional.
5. Roll bar for roll-over protection.
6. Reasonably low overall height.
7. Highly streamlined.
8. Light weight.
9. Aesthetic design qualities not presently aspired to by run-of-the-mill production automobiles.

Model construction. The building of a one-eighth scale model sports car body was considered to be a new approach to many design and construction problems in a body and fender repair laboratory (see Figure 4). Using the fixed specifications as a guide, the finished drawing was not completed at this time on paper, but instead, a preliminary drawing for further designing the clay model was made. This preliminary drawing was designated PD-50
(see Figure 5). The contour from the preliminary design was necessary to determine the shape and size of the wood armature for the clay mold as illustrated in Figure 6. Plasticized modeling clay was pushed into the holes on the surface of the armature for the adhesion of the clay that was added to build up the thickness for the initial shaping of the body. Using the contour of the preliminary drawing as a guide, the right half of the body was shaped and reshaped until a pleasing form suitable for duplication on the left side of the model was achieved.

Templates were formed at nine locations on the right side of the body to duplicate symmetrical contours on the left side, as exemplified in Figure 7.
FIGURE 6

ARMATURE FOR CLAY MODEL

FIGURE 7

METAL TEMPLATES ON CLAY MODEL
Special tools as well as existing tools for various uses were put into operation to help shape the clay model and to make possible a high quality finished project (see Figure 8).

FIGURE 8
TOOLS TO FORM CLAY MODEL

A small wood carving set was used to remove excess amounts of clay between the body stations, and the various length hack saw blades were used to dress down or plane off excess amounts of clay to the desired contour. The wide wood blade, shaped dowelings, plastic squeegee, pocket knife, and the smooth side of the hack saw blades were used to trim and smooth the clay to the desired effect. Various
tools were used to score the lines representing the openings for the doors, engine compartment, trunk space, headlights, turn signal lights, and tail lights.

The wheels and tires of the model car were one-eighth scale 6:00 x 15 inch off-set for the front and 8:00 x 15 inch off-set for the rear. Each wheel was made by utilizing a two inch concave metal drawer pull to be both the hub cap and the main structure of the wheel, as illustrated in Figure 9. The backing plate of the wheel

FIGURE 9

WHEELS AND AXLES FOR MODEL
was made of a two inch baby food jar lid that was punched in the center to fit the small side of the drawer pull. The model tire was then fastened with contact cement to the hub and backing plate to form the completed wheel and tire assembly.

Each axle for the model was constructed of three pieces. Two 8-32 machine screws were brazed to a three thirty-seconds inch iron rod to form the completed axle. The hubs of the wheels were screwed onto the ends of the axles and locked into place with jamb nuts. The complete wheel-axle assemblies were mounted into prepared slots on the bottom of the wood armature to complete the project.

The completely shaped and assembled model sports car body was scrutinized for defects which were then repaired. The clay surface of the model was given a final finish operation by rubbing the surface with many different tools while using water as a lubricant to keep the clay from building up and sticking to the implement. The smooth finish was extremely difficult to achieve because such great care was required to keep from doing damage to the project.

A code number system was developed in the finished drawing of the model sports car in order to help the reader interpret the drawings and the relationship of specific parts of the whole.
For example, Figure 10, drawing number A-50-0 is an assembly drawing. Letter A stands for assembly. 50 is an arbitrary number. 0 means that only one sheet was needed to show the assembly drawing.

Design. The construction of a full size plug mold of a sports car body was considered to be the necessary approach to form a light weight fiber glass body to fit a Volkswagen sedan chassis, as pictured in Figure 11.

The wood plug mold was altered slightly from the clay model to provide a more practical sports car. The final design incorporated the following features: (1) The windshield was moved forward and slanted to a slightly greater degree, (2) the rear deck lid was raised to provide more room for the engine, and (3) the rear end of the car was altered to enhance its over-all beauty.

Construction Stage

The construction of the fiber glass sports car body consisted of eight distinct divisions:

1. Plug mold
2. Cavity mold
3. Body shell
4. Body mounting
5. Body construction
6. Body finish
7. Electric wiring
8. Project evaluation
FIGURE 10

SPORTS CAR BODY

DRAWN BY: RICHARD E. STUTZMAN
5-12-68  SCALE: 1" = 1'  NO. A-50-0

FRESNO STATE COLLEGE

É SYMM.
Plug mold. The full size plug mold of the experimental sports car body was constructed by fabricating several parts. The mold assembly was fabricated around a torsion box made of two pieces of one-fourth inch plywood twelve inches wide and ninety six inches long, as shown in Figure 12. These two pieces of plywood were the top and the bottom which were nailed to one inch by twelve inch flat pine boards used on the sides. Each end of the torsion box was plugged with one inch boards to complete an extremely rigid back bone for the plug mold assembly.
Every twelve inch spacing on both the top and bottom of the torsion box were slats that were glued and nailed for fastening parts of the mold. These slats on the torsion box made up the nucleus of the sports car mold.

A 1967 Chevrolet Corvette windshield was installed at the desired location on the plug mold using simple wood brackets to hold the windshield in its position. The body mold was constructed around this windshield.

The center and both side bows for the top were laid out by bending a flat six-foot steel rule to determine the curvature desired. The center bow was aligned with the top
of the windshield and then the side bows were placed into position. A pine plate was cut to the top curvature of the windshield and trimmed to shape with a disc sander. The top panel of one-fourth inch plywood was glued and nailed into position to this plate with the two sides following, using the torsion box slats for easy attachment of fittings to maintain alignment.

The lower sides of the plug mold were shaped by placing a nailing strip at the bottom of the body and another nailing strip eight inches above the bottom for the break line. Both one-fourth inch plywood and one-eighth inch untempered press wood were used for surface covering of the mold in various places.

Wherever curves in the panels were severe, such as the top edges of the fenders and side body panels, wood blocks, cut to about two inches in length, were glued and nailed into place rather than a curved piece of wood shaped by steaming which would have been more difficult to manipulate. A high speed disc sander was utilized to shape the blocks for fitting their respective panels.

The front hood of the plug mold was formed using the method similar to the roof panel. Three bows were designed using the six-foot steel rule to shape a desired curve. These bows were then fastened to the torsion box in such a manner as to hold their positions for gluing and nailing the tips of the hood and fenders in place.
A simple rotating rack was formed to accommodate the body plug mold for easier construction and finishing, as exemplified in Figure 13. This rack consisted of two two inch pipes welded vertically upon plow disc bases. Supporting outriggers were attached to the torsion box of the plug mold to accommodate rotation in the holes in the pipe stands. The rotating rack was able to roll the mold a full 360 degrees, making it an extremely serviceable tool that cut considerable time in the final shaping and finishing of the project.
Body putty was used profusely throughout the complete plug mold to expedite time involved in the building of this project, as illustrated in Figure 14.

Templates were cut from press wood to aid in obtaining a symmetrical form and to aid in the distribution of body putty.

Upon completion of the plug mold, it was sprayed with several coats of lacquer base automobile primer-surfacer to fill slight depressions and scratches. Block sanding of the surface was accomplished after every three coats of primer-surfacer was applied. Spot putty was used
to assure complete filling of cavities and scratches. To finish the plug mold, a light blue lacquer was sprayed upon the surface to form a hard finish and to high-light high and low spots on the surface of the plug mold (see Figure 15).

![Lacquer Painted Plug Mold](image)

**FIGURE 15**

**LACQUER PAINTED PLUG MOLD**

Cavity mold. Industry has learned through trial and error that the simple methods of construction are not always the most economical in both time and expense. The construction of the fiber glass sports car body was approached in much the same attitude as that which the automobile industry would solve the problem. Much thought was given to the outcome of the finished body through the molding method. The seemingly simpler method of molding the
sports car body shell would have been to form the body on
the wood convex plug mold; however, due to previous
experience with other projects, and knowledge formulated
from many different automobile construction sources, the
most practical method of molding a automobile body shell
was to form a fiber glass cavity mold over the wood convex
plug mold as exemplified in Figure 16.

FIGURE 16
FIBER GLASS CAVITY MOLD

The fiber glass cavity mold had the advantage of
eliminating practically all of the contour sanding that
would have been necessary on a body formed over a convex
plug mold and far less time was expended building a
reinforced fiber glass cavity mold than it would have taken
to properly shape and finish a body formed on the plug mold. Another advantage of the cavity mold was its capability to duplicate a number of bodies in the future. The convex plug mold would have been able to form but one sports car body because the mold would be ruined when taking the finished body shell from it.

Before constructing the fiber glass cavity mold, the entire wood plug mold was again inspected for imperfections. Both spot putty and body putty were employed to fill and contour where necessary, followed by dark gray lacquer primer-surfacer which was sprayed over the repaired surface. The entire wood plug mold was then covered with several coats of mold release wax.

The fiber glass cavity mold of the sports car body was constructed in the following separate sections:

1. Windshield area
2. Front hood area
3. Top and side window area
4. Right side
5. Left side
6. Front under pan
7. Rear under pan

The windshield area cavity mold was first shaped upon the wood plug mold. Plasticized clay was placed around the windshield area to mold a one and one-half inch
lip for this section to bolt to the joining top and hood. Two light coats of polyvinyl alcohol were sprayed over the clay and the mold release wax to assure the parting of the cavity mold from the wood plug mold. The windshield cavity mold area was formed of multiple layers of two ounce fiber glass mat making about three-sixteenths of an inch thickness.

Plasticized clay was placed at the top edge of each front fender and at the separation of the front under pan and hood to form a one and one-half inch lip to the sections of the cavity mold, as illustrated in Figure 17. These lips

FIGURE 17
CLAY TO FORM LIPS ON SECTIONS OF THE CAVITY MOLD
were for the fastening together of the mold sections later. The front hood fiber glass cavity mold was formed over the wood plug mold by spraying a black gel coat onto the surface and allowing it to set. Two layers of a two ounce mat and two layers of a twenty one ounce woven roving was laid over the area using polyester resin to impregnate the material. The total thickness of the hood cavity mold was about one-fourth inch thick when it was completed. Both cardboard and fiber glass mat was used to strengthen the hood area to develop as much rigidity as possible to eliminate warping of the cavity mold as exemplified in Figure 18. The cardboard

![Figure 18: Cardboard Inverted "V" on Cavity Mold](image-url)
was formed into an inverted "V" and then it was taped to the desired position. A layer of two ounce fiber glass mat was used to cover the cardboard "V" to give the material strength.

The construction of the top cavity mold was similar to that of the hood and the other sections of the body. Plasticized clay was used to form a one and one-half inch lip at the attachment points for the rear under pan and the two sides. The top area of the plug mold was sprayed with two thin coats of polyvinyl alcohol to assure the parting of the fiber glass cavity mold from the wood plug mold. One heavy application of black gel coat was sprayed over the area and allowed to set. Two layers of two ounce mat and two layers of twenty one ounce woven roving were laminated over the top area. Cardboard, in the form of an inverted "V" was used at strategic points of the top area to eliminate any possibility of warping upon removal from the plug mold. At the base of the side windows, the fiber glass cavity mold was reinforced with strips of wood covered with mat.

Plasticized clay was used to form one and one-half inch lips on the sides at the front and rear under pans. The clay used to form the lips on the hood and top cavity mold was removed to expose the molded fiber glass lips of these sections. Polyvinyl alcohol was sprayed onto the plug mold sides, the clay, and the molded lips to form a positive parting between the plug mold and the cavity fiber
glass mold sections. One heavy layer of black gel coat was sprayed over the side areas and allowed to set over night. Two layers of a two ounce mat and two layers of a twenty one ounce woven roving were laminated to include the desired lips for later fastening of the mold sections together. Cardboard was formed into an inverted "V" shape and was taped to the desired locations requiring additional strength and rigidity. A layer of two-ounce fiber glass mat covered the "V" shape cardboard to furnish the needed strength.

Clay used to form the lips for the joining panels surrounding the front and rear under pans was removed. The under pan areas of the plug mold were sprayed with polyvinyl alcohol mold release and allowed to thoroughly dry. A heavy black gel coat of polyester resin was then sprayed on these areas and allowed to set over night. Two layers of a two ounce mat and two layers of a twenty one ounce woven roving were laminated together using polyester resin to impregnate the material.

Upon finishing the fiber glass cavity mold, a combination rotating rack and mold reinforcement for easier lamination of the body was thought necessary, as shown in Figure 19. A two inch pipe post provided with a yoke at the top was welded vertically onto a plow disc base. Two of these structures formed the supports for the cavity mold to rotate upon. One inch square steel tubing was attached to
the sides of the fiber glass cavity mold. Pads of expanded steel screen were brazed to the square steel tubing at the points of attachment to the cavity mold. Resin saturated fiber glass mat was placed between the mold and the steel screen pads, to assure a positive bond for the rotating structure. Two inch angle iron was bolted between the side structures at both the front and rear of the mold. Two inch pipe was welded to the angle iron to pivot in the yoke of the stands at either end of the fiber glass cavity mold. A one inch square tube was attached the full length on each side of the mold to prevent sagging of the sections when
the mold was rotated to various positions.

Upon completion of the mold, holes were drilled about every three inches through the lips of the fiber glass sections to accommodate 10-32 bolts to fasten the panels together. The completed fiber glass cavity mold was then rotated to the desired positions for repairing imperfections with automobile body putty. The cavity mold was finished by wet-sanding with 400 grit wet or dry sandpaper followed by three coats of mold release wax.

**Body shell casting.** The fiber glass lamination chosen for this experimental sports car body was formulated after analyzing many sources of information. Reasonable economy of material combined with high strength were achieved by laminating a two ounce mat with the gel coat, on the surface of the body, with twenty one ounce woven roving on the inside surface. This lamination averaged about .135 of an inch in thickness.

The cavity mold was rotated upside down and polyvinyl alcohol mold release was sprayed over the mold release wax. The surface of the mold was sprayed with three coats of clear polyester resin to form the gel coat. After the gel coat hardened, a two ounce fiber glass mat was applied, overlapping about two inches at all joints. Twenty one ounce woven roving was laminated over the two ounce mat for the final layer of the fiber glass.
The new laminated body shell was left to season in the cavity mold for a period of one week. The cavity mold was unbolted and each section was easily released from the new body shell. A saber saw was used to trim the flashing around the windows and the bottom of the body.

**Body mounting.** The sports car body shell was mounted on a 1960 Volkswagen chassis by using the inner panels from a damaged Volkswagen sedan. These inner panels were cut down where necessary and one-eighth inch press wood was screwed or riveted to the panels for the proper fit. Fiber glass was then used to fasten the inner panels to the fiber glass outer body shell for a solid bond.

**Body construction.** The windshield was fitted to the body shell by minor trimming and sanding of the fiber glass body. A three-eighths inch sheet metal angle was screwed into place around the windshield opening to provide an anchor to hold the windshield rubber weather strip in place.

With the windshield in place to maintain proper body rigidity, the headlights, front hood, rear deck lid, and both doors were cut in the fiber glass body shell with a saber saw. The inner panel beneath the front hood was completed to support the nose section of the body and to divide the headlights from the front trunk area. Angle
sheet metal was riveted to the inner panels, surrounding the front trunk and the rear engine area, to accommodate rubber weather stripping. Both the front trunk lid and the rear deck lid were reinforced on the edges with sixteen gauge angle iron to retain the proper shape of these sections.

The front hood hinges were made with one-fourth inch diameter carbon steel welding rod with rod reinforcement. The hood latch was a unit from a 1962 Volkswagen. A cable release was attached to the hood latch and was accessible under the left side of the instrument panel.

The rear deck lid hinges were made of sixteen gauge sheet metal. More difficulty was encountered with the rear deck lid hinges because of the interference of the engine fire wall. The deck lid was latched in a manner similar to that of the front hood, using a 1964 Volkswagen latch and a flexible cable release located behind and to the left of the driver's seat.

The retracting headlights were the most time consuming sections of the body to build and perfect (see Figure 20). A practical method of extending and retracting the headlights was discovered after making many sketches and diagrams, cardboard and wire models, and attempting three different installations. The final retracting mechanism functioned by a simple push or pull of a lever located to
the left of the steering post under the instrument panel. When the lever was pulled out the headlights were raised; when the lever was pushed in the headlights were retracted. This lever was connected to a torsion bar that had bell cranks attached to raise or lower each headlight. The large panel over each headlight had a piano hinge riveted at its rear which was screwed to an angle iron. The angle-iron was riveted to the fender above the front wheel. These panels were held against the top of the headlights by springs which allowed them to raise and lower with the actuation of the lights. The small panel in front of each headlight was actuated by the retracting mechanism which
depressed a lever to place the panel in its proper position. The small panels in front of the headlights depressed when the headlights were in the raised position and they were flush with the top of the fender when the headlights were in the down position.

The door openings at the side of the body were built of one-eighth inch press wood with fiber glass mat reinforcement for both strength and weather proofing. The door sill was designed to aid body rigidity at the rocker area as well as to function as the interior heater tubes. Three-fourths inch clearance was provided for rubber weather stripping at the door sills and the door striker post. Door hinges were from a 1951 Chrysler sedan. These hinges had plates welded in place for fastening to the doors. The door latches and striker plates were from a 1958 Chevrolet. This type of latch provided a push button rotary door latch. The inner door panels were constructed of one-eighth inch press wood and two ounce fiber glass mat reinforcement. The door window glass was of one piece reinforced with metal channel. Conventional window runners were set parallel at the front and the rear of the glass and a five-eighths inch rod was fastened in the center area of the window mechanism to allow the window to raise and lower as well as to keep the window from tilting out of its channel runners, as pictured in Figure 21. A 1951 Chrysler
ELECTRIC WINDOW LIFT MECHANISM

electric window lift was used in each door to actuate the windows. The control switches for the windows were located in the center area of the instrument panel beneath the radio.

The rear window and the two side rear quarter windows were made of ninety-thousandths inch aircraft plastic windshield material. The plastic window material was cut with a slow speed saber saw using a blade with thirty-two teeth per inch. A special rubber molding was used to mount the windows into place.
Body finish. Due to haste and inexperience in laminating the fiber glass sports car body, some air bubbles were formed between the gel coat and the fiber glass mat. The surface of the body was meticulously inspected for these air bubbles that could later cause surface damage. A small three inch sanding disc on a portable air drill was used to sand the body wherever these air bubbles appeared near the surface. Polyester automobile body putty was then used to fill all surface imperfections.

The entire body was sprayed with three coats of alkyd resin type primer-surfacer. The primer-surfacer was water sanded with 320 grit wet or dry sandpaper, and any imperfections that were detected were filled with spot putty. A final light coat of primer-surfacer was applied over the fiber glass surface and again lightly water sanded using 400 grit wet or dry sandpaper. One quart of non-sanding sealer was sprayed on the body to seal the sandpaper scratches before applying the finish paint.

Three quarts of acrylic lacquer was sprayed onto the surface of the car for the final finish color coat of paint. The surface of the body was lightly water sanded with 600 grit sandpaper and then hand-rubbed with a medium and then a fine rubbing compound.
**Electric wiring.** The fiber glass sports car was wired similarly to a conventional 1963 Volkswagen sedan (see Figure 22). The two changes that were different from the Volkswagen were the addition of the electric window lifts and the running of ground wires to the frame of the car due to the insulation qualities of fiber glass material.

The tail light boxes were made of cold rolled sheet metal. Each tail light used two 1958 Chevrolet sockets and a two-element and one-element light bulb. The red lenses for the tail lights were from a 1968 Chevrolet Caprice station wagon. The front turn signal lights were from a 1960 Volkswagen sedan.

**Project evaluation.** The fiber glass prototype sports car body functioned as it was intended. The vehicle was a practical machine suitable for travel on both the highway and the city street. Visibility to the front and to the sides was excellent. The visibility to the rear was more than adequate due to the inside center mirror plus the two outside mirrors on each front fender. Backing the automobile presented no problem due to the visibility through the large rear window and the two rear quarter windows. The fiber glass seat was adequate and comfortable for a short person. A taller individual could drive the car, but the seat would have to be designed differently for maximum comfort. The steering wheel position was not
FIGURE 22

A BATTERY
N IGNITION DIST.
B STARTER
O IGNITION COIL
C GENERATOR
P SPARK PLUG WIRES
D IGNITION/START SW.
E WIND. WIPER SW.
F LIGHT SWITCH
G TURN SIG. SW.
H HORN SWITCH
I WIND. WIPER MOT.
J FLASHER UNIT
K HIGH BEAM IND.
L HEAD LT. LEFT
M HEAD LT. RIGHT
N IGNITION DIST.
O IGNITION COIL
P SPARK PLUG WIRES
Q RADIO
R RADIO ANTENNA
S TURN IND. LEFT
T TURN IND. RIGHT
U DOOR LT. SW.
V WIND. WIPER MOT.
W WIND. WIPER MOT.
X STOP TAIL FL. LT.
Y STOP TAIL FL. LT.
Z DOME LIGHT
A OIL PRES. SW.
B LIC. PLATE LT.
C WINDOW LIFT MOT.
D WINDOW LIFT MOT.
E WINDOW LIFT RELAY
F WINDOW LIFT RELAY
G OIL PRES. LT.
H WIND. LIFT SW.
I WIND. LIFT SW.
J WIND. LIFT SW.
K WIND. LIFT SW.
L WINDOW LIFT SW.
M WINDOW LIFT SW.
N WINDOW LIFT SW.

FRESNO STATE COLLEGE
ELECTRIC WIRING DIAGRAM
DRAWN BY: RICHARD E. STUTZMAN
5-12-68 NO. E W 60-0
tiring, though neither the seat nor the steering wheel was adjustable.

The side air scoops, located behind the rear quarter windows, furnished fresh cool air for the engine. The two tunnel air scoops in the rear deck lid were also functional to furnish air for the carburetor. The tuned exhaust further helped to keep the engine cool. However, the primary purpose of this exhaust system was to fill in the rear of the body for a more pleasing appearance.

The automobile turned or cornered very flat due to its extremely low center of gravity. The overall performance was very good, being both a lighter car and much more streamlined than a standard Volkswagen sedan. The ride was good with a minimum amount of road roughness. This fiber glass body changed the basic Volkswagen to a new kind of inexpensive sports car.
CHAPTER III

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary and Conclusions

This study was concerned with the design, construction, and evaluation of a fiber glass sports car body mounted upon a Volkswagen sedan chassis, and the construction procedures necessary for its incorporation as a problem in the body and fender repair laboratory at East Bakersfield High School, Bakersfield, California.

The automobile body shell was constructed from laminated fiber glass and consisted of the following major parts:

1. Main structure
2. Right door
3. Left door
4. Front hood
5. Right headlight covers
6. Left headlight covers
7. Rear deck lid
8. Windshield
9. Rear plastic window
10. Right and left door windows
11. Right and left rear quarter plastic windows
The construction of the fiber glass sports car body was undertaken after careful study of prototype, custom and production sport cars. Various features, such as materials of construction, dimensions, safety, comfort, performance, and aesthetic design were carefully analyzed.

Although many production sport cars are constructed of steel or aluminum, it was considered more desirable to use fiber glass in the construction of the prototype body in this study.

The sports car body outer shell was constructed from two ounce fiber glass mat laminated with polyester resin to twenty one ounce woven roving. The inner panels supporting the body were Volkswagen modified with one-eighth inch press wood screwed or riveted in place. All inner panels constructed of press wood were covered with one and one-half ounce fiber glass mat where necessary for gaining greater strength.

The completed fiber glass bodied sports car project required about 2,300 hours time from the beginning of the clay model to the completion of the car. Much of the time consumed in the production of this prototype sports car was due to the inexperience of the experimentor. Many mistakes were made and rectified. However, there were some mistakes that had to be accepted which contributed to unfavorable conditions.
Since this project was so time consuming, it seems reasonable to conclude that there should be four main divisions which the high school body and fender laboratory should consider before attempting to build a project of this magnitudo from the beginning to the end:

1. The design of the project in clay model form will speed up the building of the project.

2. The full size exterior plug mold.

3. The fiber glass cavity mold with the sports car body made in the mold.

4. The mounting of the fiber glass body upon the chassis of the automobile, fitting all inner panels, window lifts, and other necessary hardware.

Recommendations

The following recommendations are made to further increase the usefulness of the fiber glass sports car body for a learning project in a high school body and fender laboratory:

1. Design a fiber glass body with as few separate panels and openings as necessary. The fitting of the panels and the inner panels consume a tremendous amount of time and patience.
2. Use plasticized clay or other suitable material to form projects in miniature before attempting to build full size molds.

3. Use any material necessary to accomplish adequate construction.

4. Attempt to finish the project as quickly as possible to hold the maximum amount of interest of those students associated with the production.

5. Investigate sources of supply for both quality and prices.
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